

MAPSS and AeroStat: integrated analysis of aerosol measurements using Level 2 Data and Point Data in Giovanni

Maksym Petrenko
Charles Ichoku
(with the help of Greg Leptoukh)
(NASA/GSFC)

Aerosols

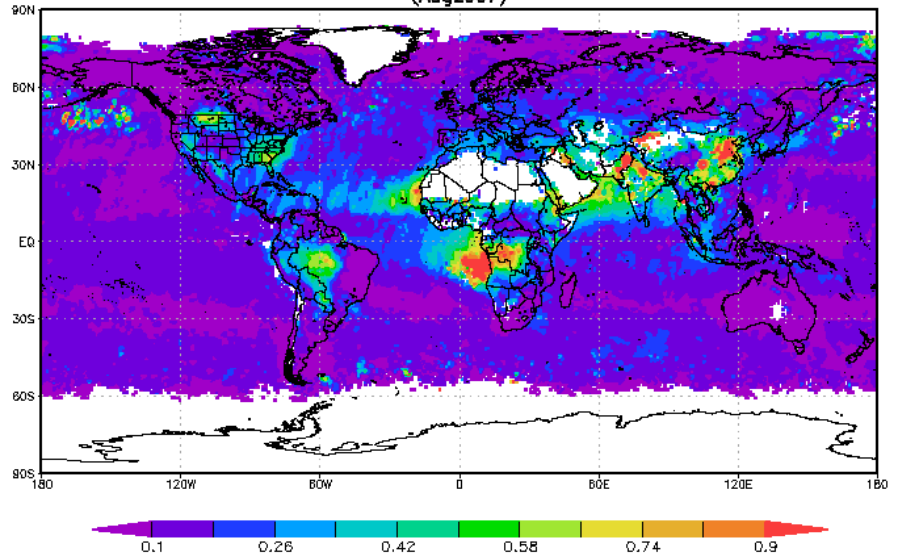
- Impact air quality, hydrological cycle, climate
- Aerosol measurements available from **multiple** spaceborne and ground-based sensors, *however*:
 - Which of the available aerosol product to use?
 - At what location?
 - At what season?
 - Under what conditions?
- It is **necessary to cross-validate aerosol products** to better understand their relative uncertainties and limitations

Multi-sensor aerosol analysis using Giovanni

<http://disc.sci.gsfc.nasa.gov/giovanni/>

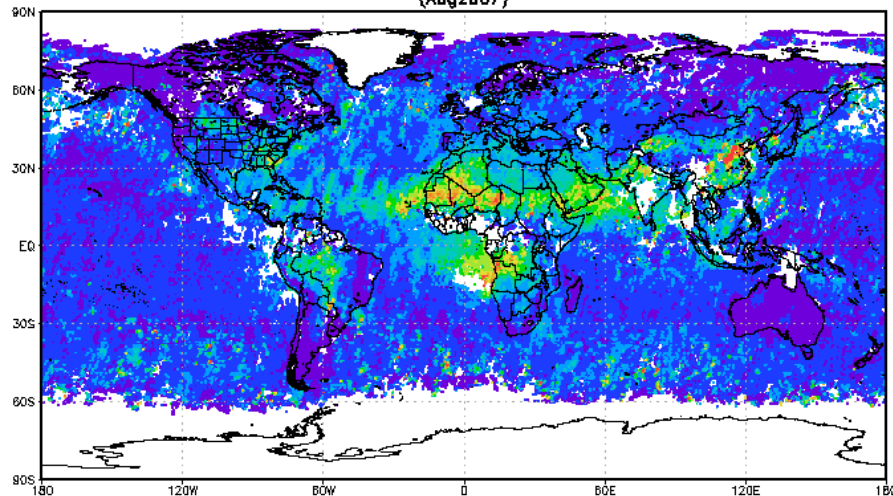
Global AOD during August 2007

MOD08_M3.051 Aerosol Optical Depth at 550 nm [unitless]
(Aug2007)



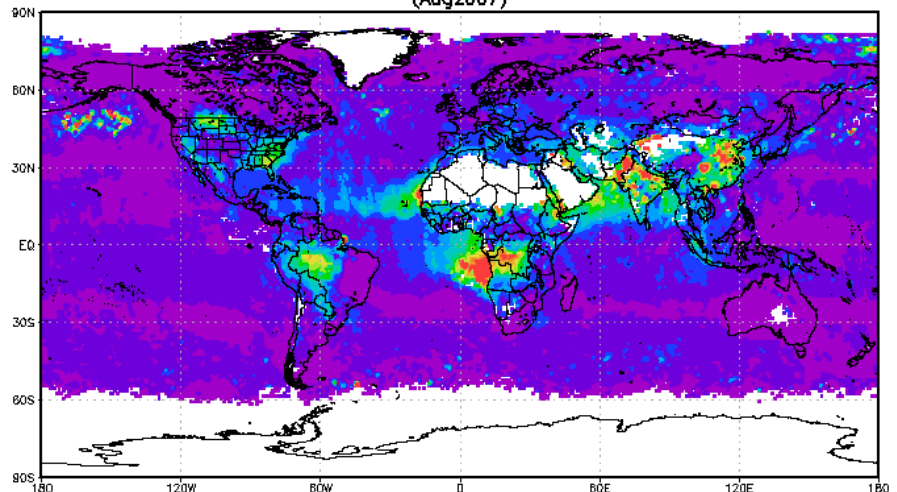
MODIS Terra

MIL3MAE.004 Aerosol Optical Depth at 555 nm (Green Band) [unitless]
(Aug2007)



MISR

MYD08_M3.051 Aerosol Optical Depth at 550 nm [unitless]
(Aug2007)

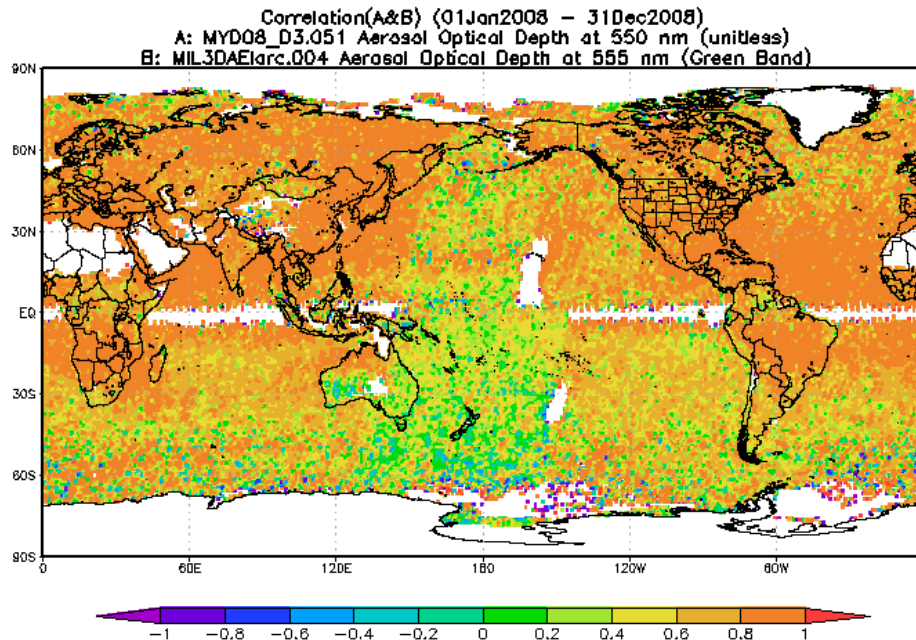


MODIS Aqua

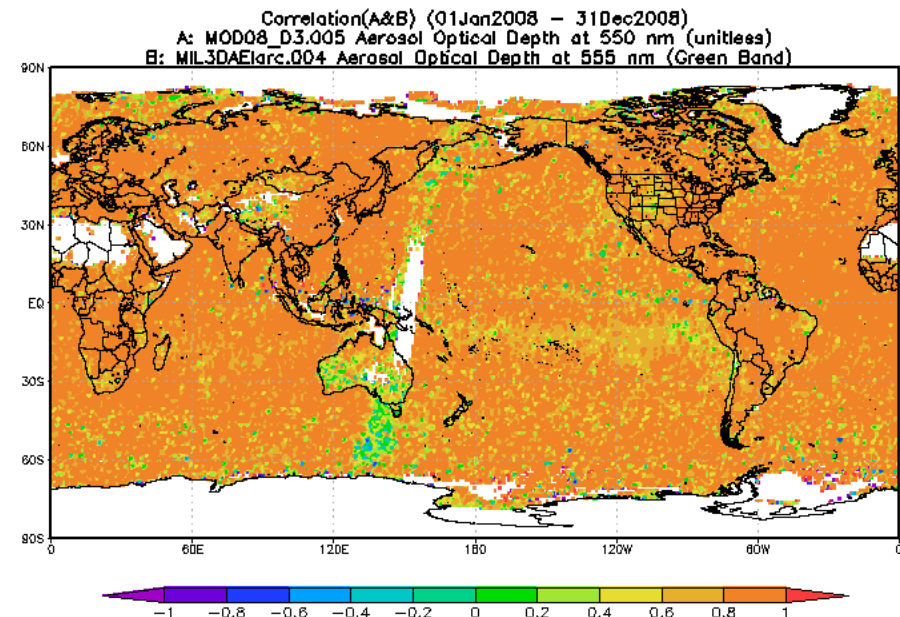
Aerosol Sensors and Products

Sensor	Platform	Spatial Resolution (Level 2)	Equator crossing time*	Data period	Features
AERONET	Ground-based	N/A	N/A	Varies with sites	High accuracy
MODIS	Terra Aqua	10x10 km	10:30 am 1:30 pm	Jan'00- Jul'02-	High spatial coverage
MISR	Terra	17.6x17.6 km	10:30 am	Jan'00-	Multiple viewing angles
OMI	Aura	13.7x23.7 km	1:38 pm	Oct'04-	Absorption, SSA
POLDER	ADEOS ADEOS-2 PARASOL	19x19 km	1:30 pm	Oct'96-Jun'97 Apr'03-Oct'03 Mar'05-	Polarization
CALIOP	CALIPSO	5x0 km	1:32 pm	Jun'06-	Vertical profile
SeaWiFS	SeaStar	13.5x13.5 km	12:00 pm	Jan'98-Dec'10	The longest time span, precise calibration

Challenges in multi-sensor analysis using Level-3 data

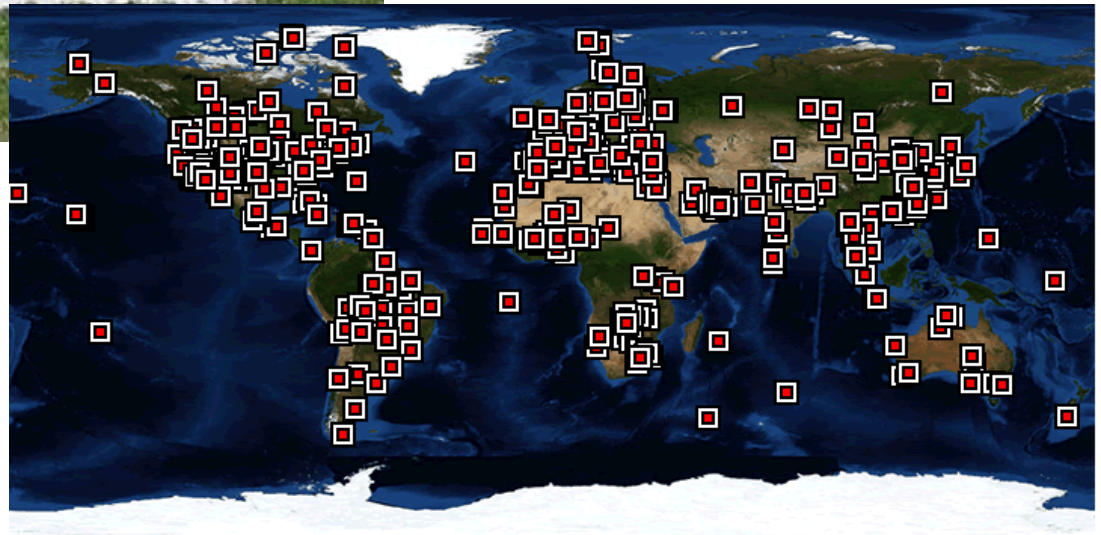


<<< AOD Aqua MODIS vs MISR
correlation map for 2008



MODIS-Terra vs. MISR-
Terra: Map of AOD
temporal correlation >>>

Aerosol retrieval reference: AERONET

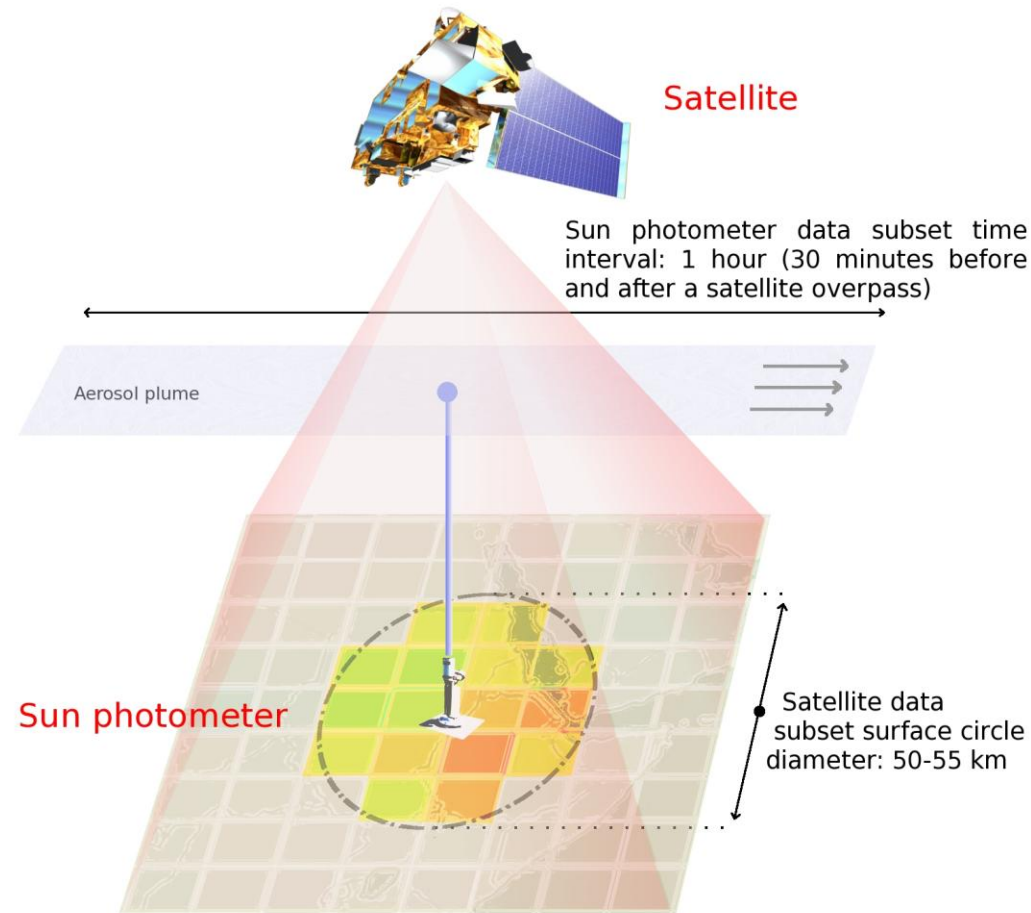




- Aerosol data are available from different sensors
 - MODIS
 - MISR
 - OMI
 - POLDER
 - CALIOP
 - AERONET
- Hard to compare and inter-validate
 - Different spatial and temporal resolution
 - Different data access strategies



MAPSS: Multi-sensor Aerosol Products Sampling System



MAPSS uniformly samples Level-2 aerosol products and stores resulting statistics in simple CSV files

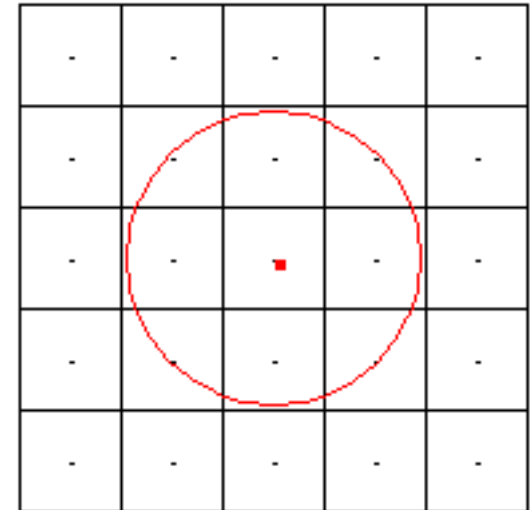
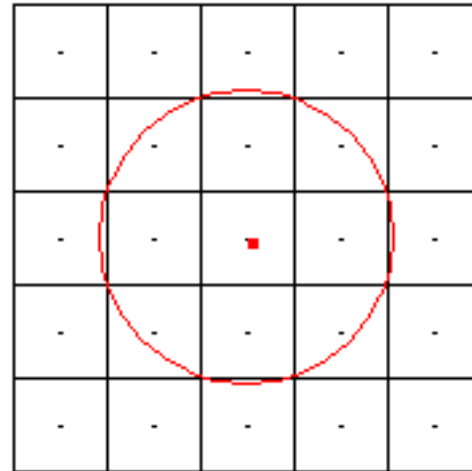
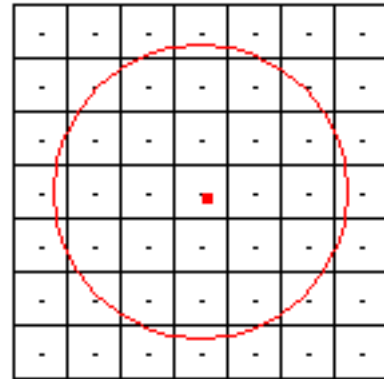
Giovanni-based WEB interface for MAPSS provides a convenient customized access to the data, with on-line plotting and data export capabilities

Sensor ground footprint (at nadir)

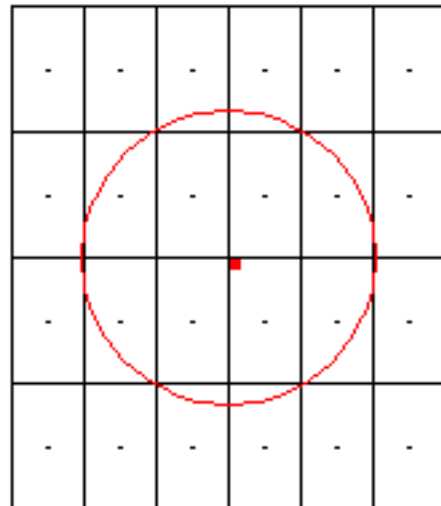
MODIS

MISR

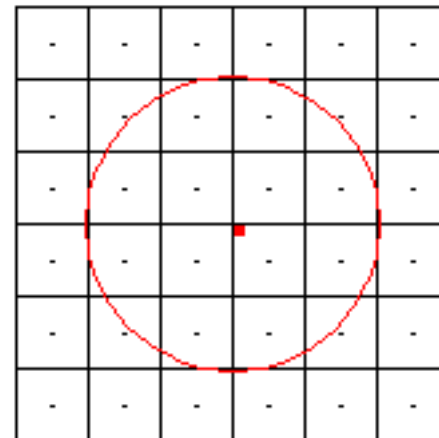
POLDER



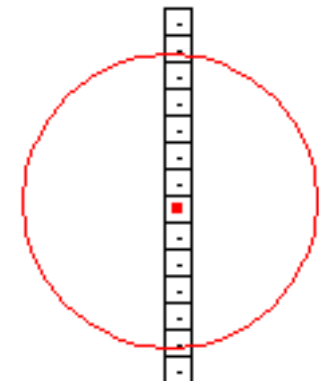
OMI



SeaWiFS

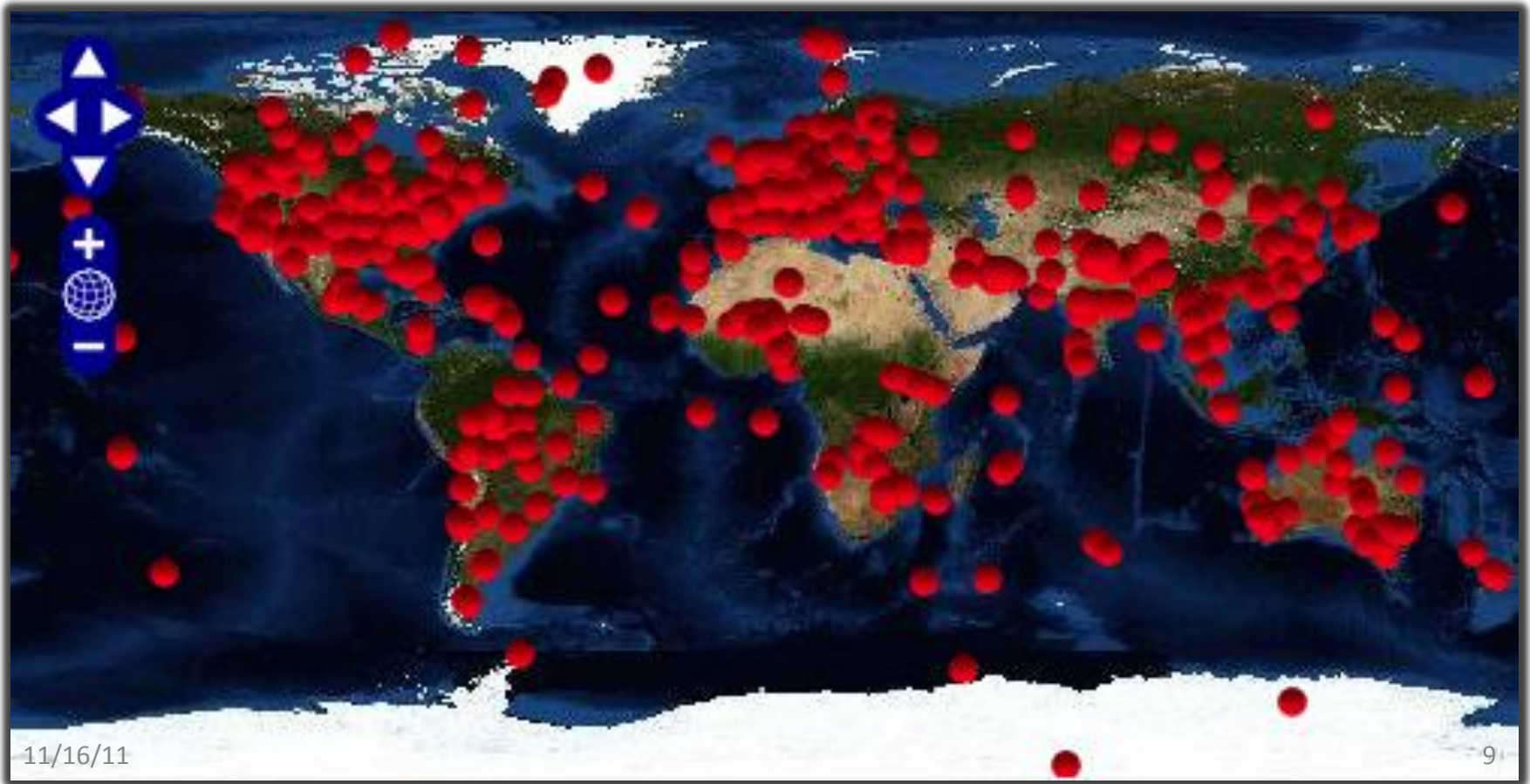


CALIOP



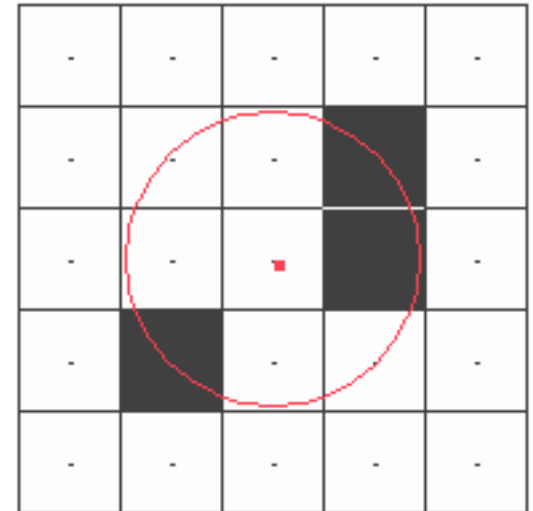
MAPSS coverage

- 659 sampling locations
 - 540 AERONET locations



Subset statistics

- General
 - Number of pixels in sample space (Ndat)
 - Valid pixel count (Nval)
 - Closest pixel value (Cval)
 - Mean, Median, Mode
 - Standard Deviation
- Spatio-temporal variability
 - Slope of fitted Plane or Line
 - Azimuth (direction) of slope
 - Multiple (or Linear) Correlation Coefficient



Ndat=9
Nval =6

Additional subset data

- Geometry
 - Solar zenith angle
 - Sensor zenith angle
 - Scattering angle
 - ... and so on
- Data provenance
 - Name of source data file
 - Index of the closest pixel in the data file
- Quality control / Quality assurance (QA)
 - Mode or mean of QA flags in the subset area
 - Bit mask flags are decoded and reported as plain numbers

MAPSS data files

Each line represents a single data point, and contains:

- Date, Time, Location (Name and Lat/Lon)
- Geometry
- QA
- Layers, each containing statistics for a particular aerosol parameter

Date	Time	Orbit	HDFfile	Location	Longitude	Latitude	block	rowc	icolc	ndat	nchan	QA	cval_AOD0446b	nval_AOD0446b	mean_AOD0446b	medn_AOD0446b	sdev_AOD...	slop_AOD...	slaz_AOD0446b	mcoc_AOD0446b	cval_AOD0558b	nval_AOD...	mean_AOD...
2009-11-30	17:31	52940	MISR_AM1_...	CART_SITE	-97.486	36.607	61	5	24	8	4	1	0.073	7	0.073	0.071	0.0070	3.642	48.41	0.938	0.052	7	0.054
2009-11-30	17:31	52940	MISR_AM1_...	Cart Site	-97.486	36.607	61	5	24	8	4	1	0.073	7	0.073	0.071	0.0070	3.642	48.41	0.938	0.052	7	0.054
2009-11-30	17:25	52940	MISR_AM1_...	Churchill	-93.818	58.736	44	1	4	7	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	17:32	52940	MISR_AM1_...	Geronimo_TOM...	-97.93	29.61	66	8	32	1	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	17:30	52940	MISR_AM1_...	Hillsboro_KS	-97.301	38.305	60	2	22	7	4	1	0.044	7	0.052	0.049	0.0090	3.304	324.388	0.872	0.029	7	0.035
2009-11-30	17:31	52940	MISR_AM1_...	IHOP-Homestead	-100.606	36.558	61	7	8	7	4	1	0.048	7	0.053	0.048	0.011	4.04	200.949	0.824	0.025	7	0.031
2009-11-30	17:30	52940	MISR_AM1_...	KONZA_EDC	-96.61	39.102	59	5	25	9	4	1	0.064	9	0.051	0.05	0.0060	0.458	17.343	0.185	0.05	9	0.033
2009-11-30	17:31	52940	MISR_AM1_...	LW-SCAN	-97.979	34.96	62	8	24	8	4	1	0.075	8	0.068	0.067	0.0040	0.483	208.051	0.336	0.053	8	0.048
2009-11-30	17:31	52940	MISR_AM1_...	Lamont_OK	-97.485	36.606	61	5	24	8	4	1	0.073	7	0.073	0.071	0.0070	3.642	48.41	0.938	0.052	7	0.054
2009-11-30	17:27	52940	MISR_AM1_...	Pickle_Lake	-90.218	51.449	49	3	30	7	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	17:31	52940	MISR_AM1_...	Purcell_OK	-97.415	34.969	62	7	27	8	4	3	--	3	0.061	0.064	0.012	--	--	--	--	3	0.04
2009-11-30	17:29	52940	MISR_AM1_...	SMEX	-93.664	41.936	56	8	32	1	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	17:30	52940	MISR_AM1_...	Shelton	-98.76	40.75	58	4	12	9	4	3	--	3	0.053	0.046	0.016	--	--	--	--	3	0.033
2009-11-30	17:29	52940	MISR_AM1_...	Sioux_Falls	-96.626	43.736	55	8	16	7	4	3	--	4	0.048	0.047	0.0080	--	--	--	--	4	0.032
2009-11-30	17:32	52940	MISR_AM1_...	TSU_SM_TX	-97.946	29.888	66	8	32	4	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	17:31	52940	MISR_AM1_...	Vici_OK	-99.204	36.071	62	2	17	8	4	3	--	4	0.052	0.052	0.0040	--	--	--	--	4	0.032
2009-11-30	19:04	52941	MISR_AM1_...	Fort_McMurray	-111.476	56.752	44	7	30	8	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	19:08	52941	MISR_AM1_...	HJAndrews	-122.224	44.239	55	5	12	7	4	3	--	2	0.101	0.101	0.0040	--	--	--	--	2	0.061
2009-11-30	19:06	52941	MISR_AM1_...	Kelowna	-119.373	49.955	50	8	15	8	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	19:09	52941	MISR_AM1_...	Lake_Tahoe	-120.104	39.171	59	4	31	8	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	19:06	52941	MISR_AM1_...	Lochiel	-122.602	49.028	51	8	3	9	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	19:10	52941	MISR_AM1_...	MONTEREY	-121.79	36.8	61	4	26	8	4	3	--	2	0.083	0.083	0.0030	--	--	--	--	2	0.07
2009-11-30	19:08	52941	MISR_AM1_...	Metolius_Old_Pine	-121.622	44.499	55	3	14	8	4	3	--	1	0.073	0.073	--	--	--	--	--	1	0.06
2009-11-30	19:10	52941	MISR_AM1_...	Monterey	-121.855	36.593	61	5	26	7	4	3	--	3	0.083	0.083	0.0020	--	--	--	--	3	0.07
2009-11-30	19:10	52941	MISR_AM1_...	Moss_Landing	-121.788	36.793	61	4	26	8	4	3	--	2	0.083	0.083	0.0030	--	--	--	--	2	0.07
2009-11-30	19:07	52941	MISR_AM1_...	Richland	-119.28	46.34	53	6	22	8	4	3	--	0	--	--	--	--	--	--	--	0	--
2009-11-30	19:07	52941	MISR_AM1_...	Timnook	-116.992	46.487	53	4	31	8	4	3	--	0	--	--	--	--	--	--	--	0	--

Auxiliary information

Statistics for layer 1

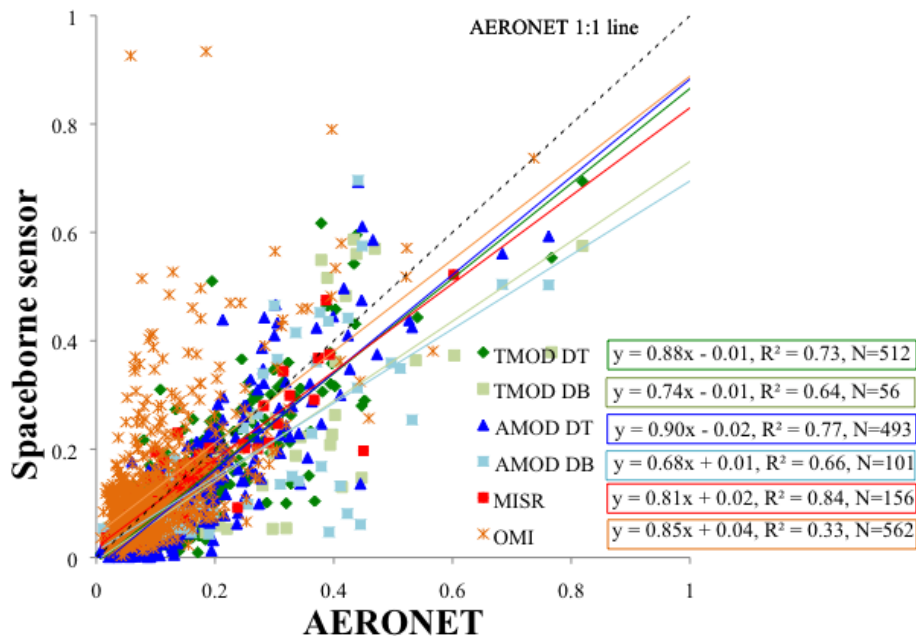
Statistics for layer 2

Sampled and stored daily to the WEB archive

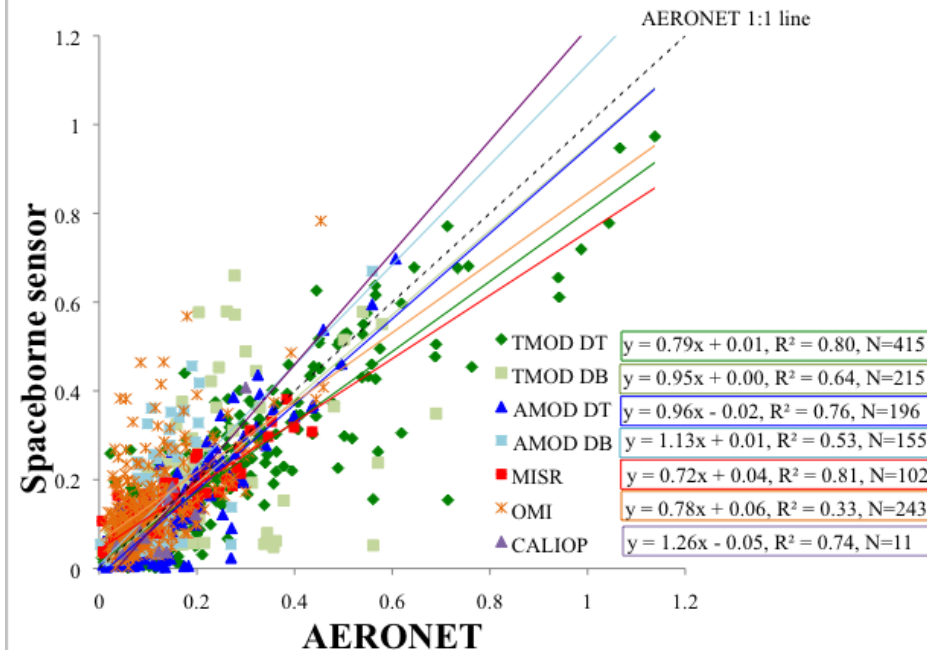
<http://modis-atmos.gsfc.nasa.gov/MAPSS/>

Multi-sensor AOD analysis using MAPSS

Mean AOD at Evora
(MODIS:550nm, MISR:558nm, OMI: 500nm)

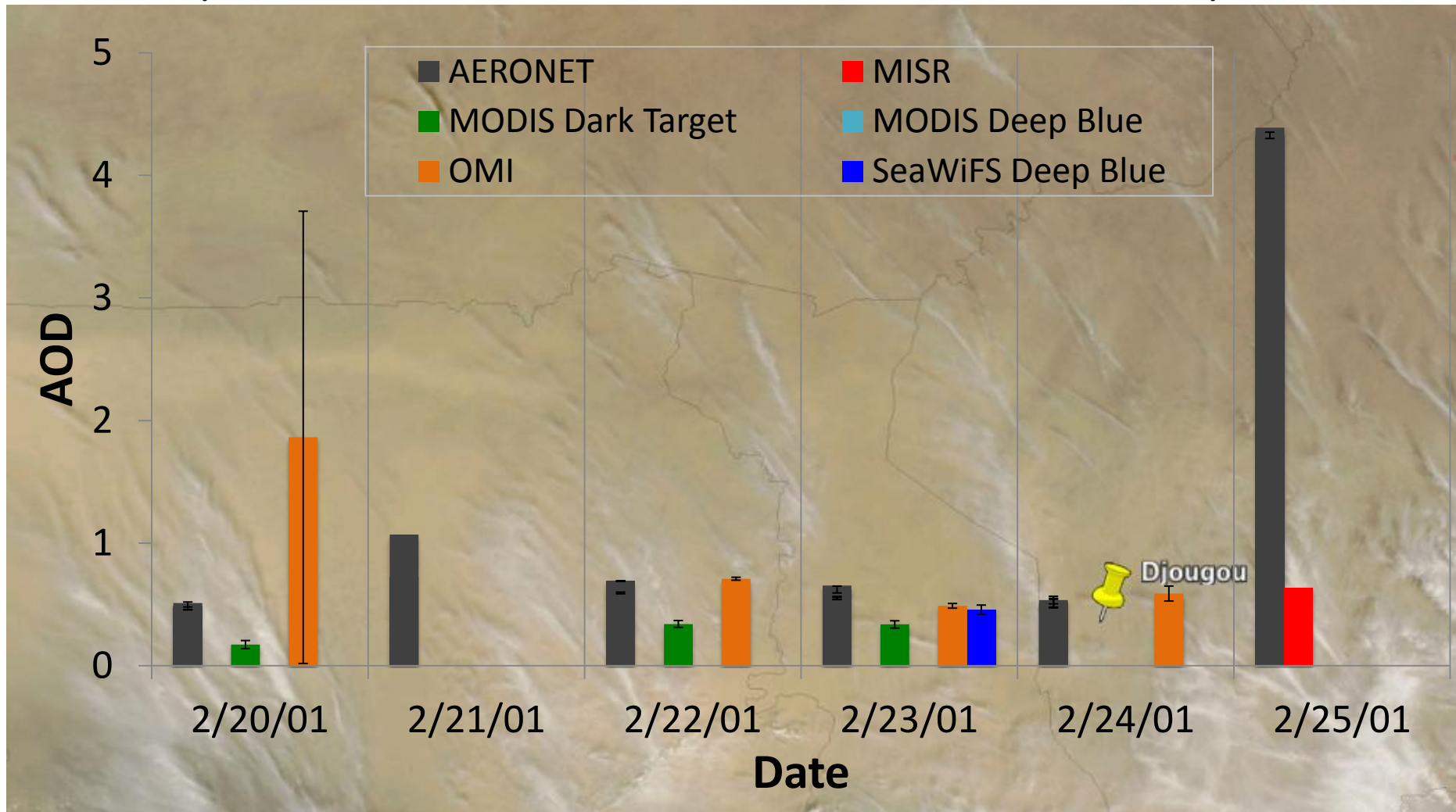


Mean AOD at BONDVILLE
(MODIS:550nm, MISR:558nm, OMI: 500nm, CALIOP:532nm)



Best-QA mean AOD from multiple sensors at Djougou

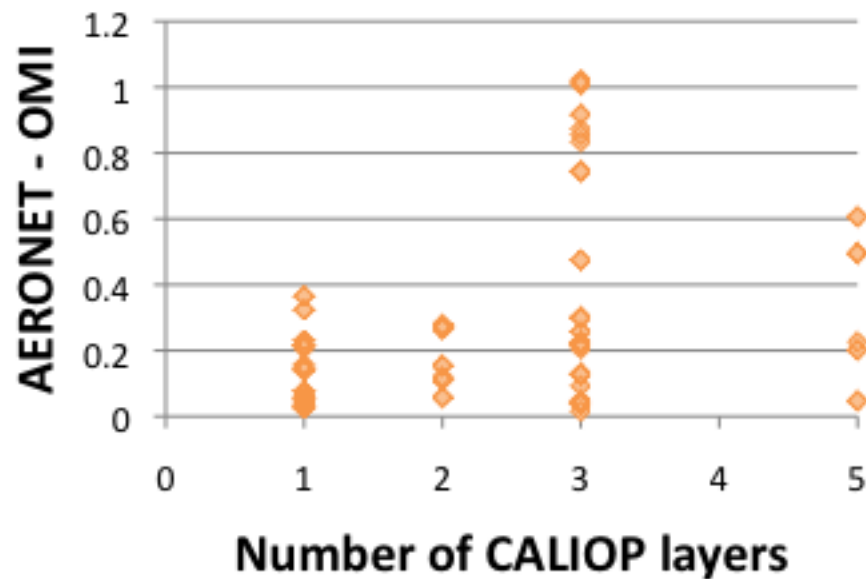
(AERONET, MODIS and SeaWiFS at 550nm, MISR at 555nm, OMI at 500nm)



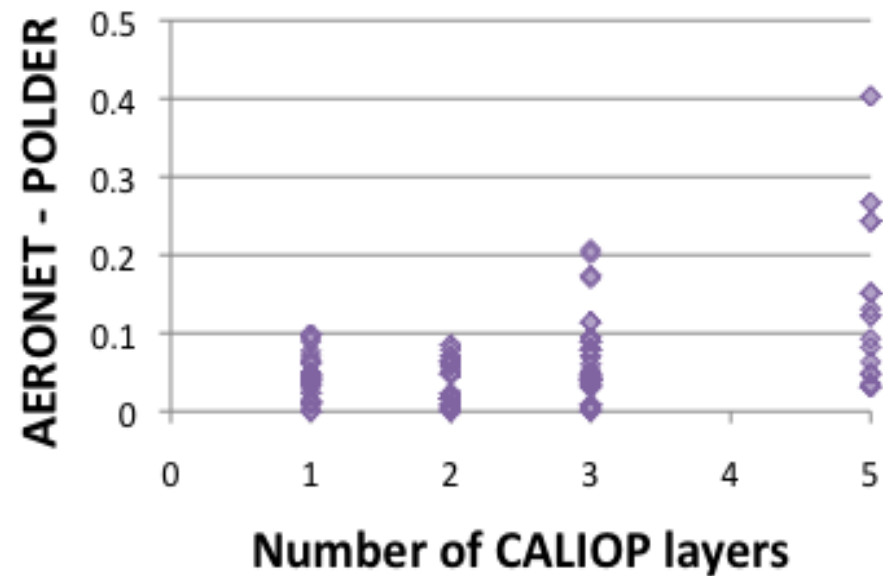
- The event was observed by multiple sensors, but most best-QA measurements underestimated the actual AOD value
- Interestingly, there were no best-QA Deep Blue AOD retrievals from MODIS, but there were some from SeaWiFS

Cross-sensor multivariate analysis

Aerosol layers and difference in AOD at Dakar

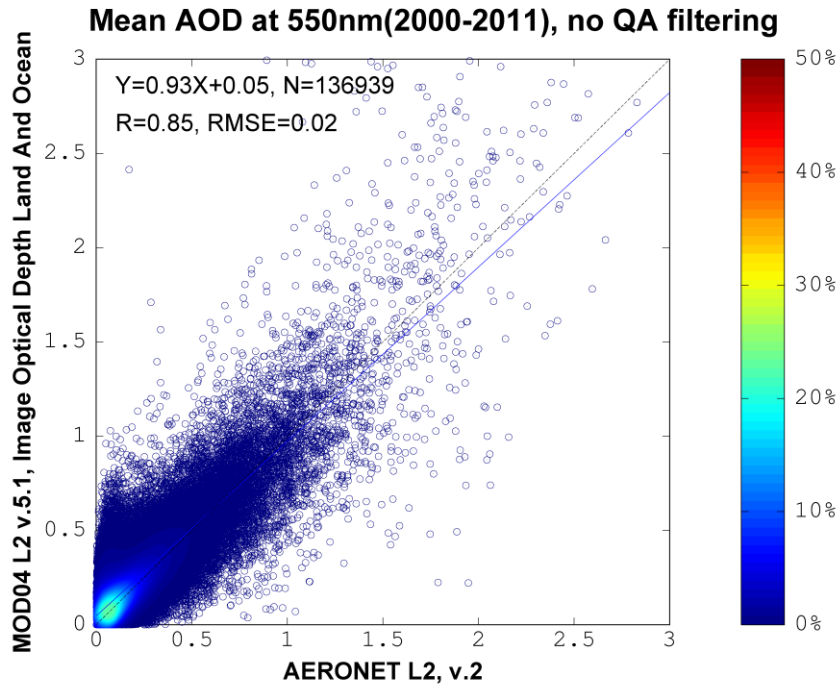


Aerosol layers and difference in AOD at Dakar

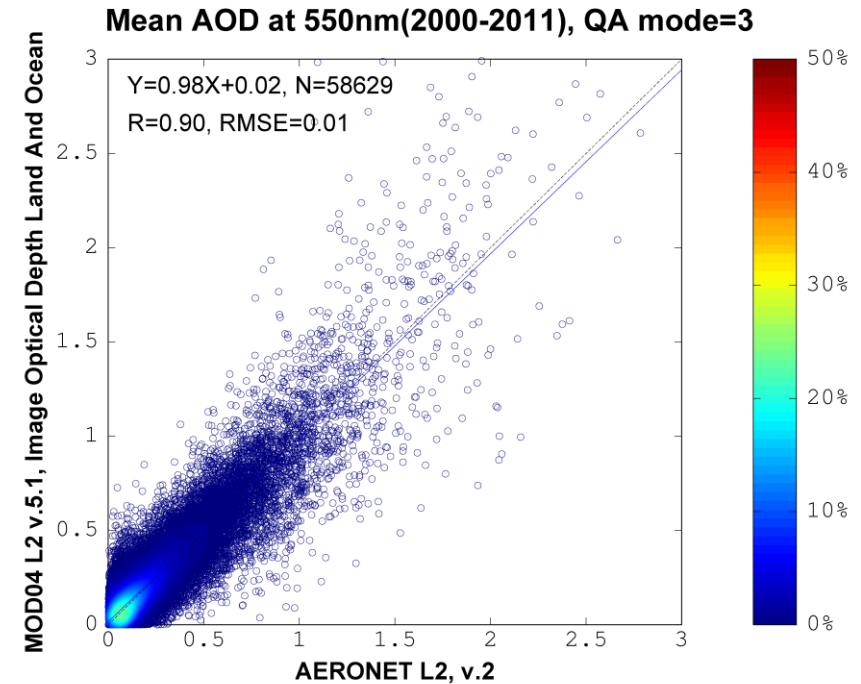


Accounting for data quality

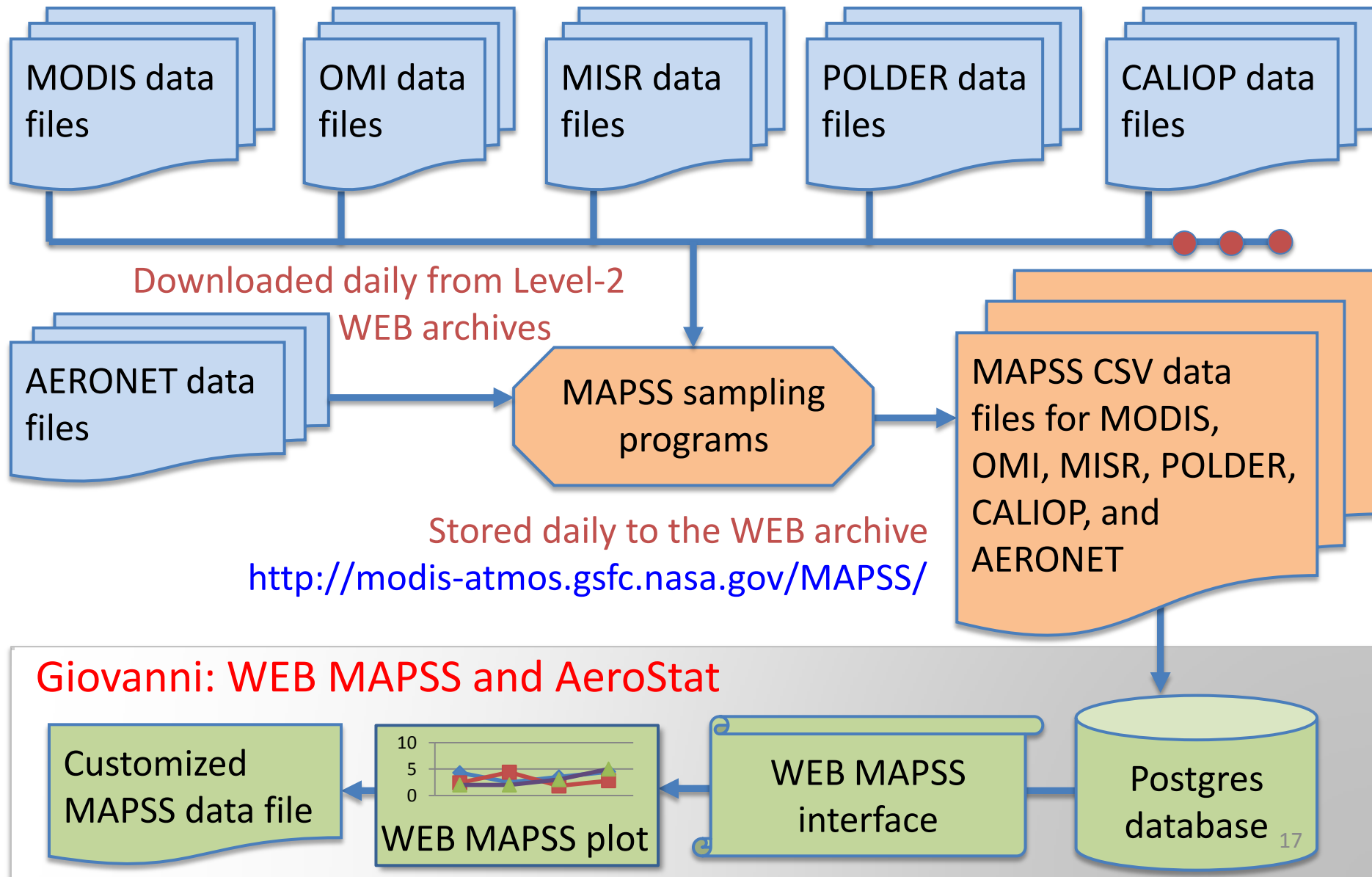
MODIS data with **all** QA



MODIS data with **best** QA



MAPSS workflow



MAPSS in Giovanni (WEB MAPSS)

- Interactive MAPSS data analysis system
- Online plotting
 - Time series
 - Scatter plot (coming)
- Customized CSV files with selected MAPSS data
- Interactive data filters
 - QA (**with explanations!**)
 - nval (number of sampled pixels with non-fill values)
- Condensed documentation for the supported products

MAPSS: Multi-sensor Aerosol Products Sampling System **HELP**

This user interface is used to obtain selected parameter statistics from the [MAPSS](#) database for a chosen location and time period. Time Series Plot is the available service. Plot output is rendered as a graph and is also available in ASCII format.

Data Selection **Results**

To see time series plots of MAPSS data, choose from the criteria below and click **Get Plot(s)**

Select Station
CSFC

Select Parameters
To select parameters, make a single selection from each list below (beginning with the left-most list), and then click 'Add'. Selected parameters will be added to the summary. Repeat for additional parameters.

☒ Basic ☐ Advanced

Product	Parameter	Layer	Variable
MODIS water vapor L2 (Terra)	Best AOD	Best AOD at 354nm	Central value
MODIS water vapor L2 (Terra)	Best SSA	Best AOD at 388nm	Mean
OMI aerosols L2, ver. 003	Best absorption AOD	Best AOD at 500nm	Median
POLDER-1 aerosols over land L2	Lambert equivalent reflectivity		Standard deviation
POLDER-2 aerosols over land L2	Surface albedo		

Selected Measurements

MODIS aerosols L2 (Aqua), ver. 051 : Corrected AOD - land : AOD at 550nm - land : Mean

No. of pixels with value: ☒ All ☐ >= 5

Quality over land: ☐ All ☐ >= 1 (Marginal or Better) ☐ >= 2 (Good or Better) ☒ >= 3 (Very Good)

OMI aerosols L2, ver. 003 : Best AOD : Best AOD at 500nm : Mean

No. of pixels with value: ☒ All ☐ >= 2

Final algorithm flag: ☐ All ☒ =0 (Most reliable) ☐ <=2 (Less reliable)

Select Date Range

Enter date(s) as YYYY-MM-DD or use calendars.

Date Range: 2007-09-01 to 2007-12-01

To see time series plots of MAPSS data, choose from the criteria above and click **Get Plot(s)**

ACKNOWLEDGMENT: Support for the development of this data access system for integrated validation, intercomparison, and analysis of aerosol products from multiple satellites has been provided by NASA HQ (PM: Stephen Berrick) through the [ROSES 2006 ACCESS Program](#) (PI: Charles Ichoku). The [AERONET](#) data are contributed by the International AERONET Federation (PI: Brent Holben).

<http://giovanni.gsfc.nasa.gov/mapss/>

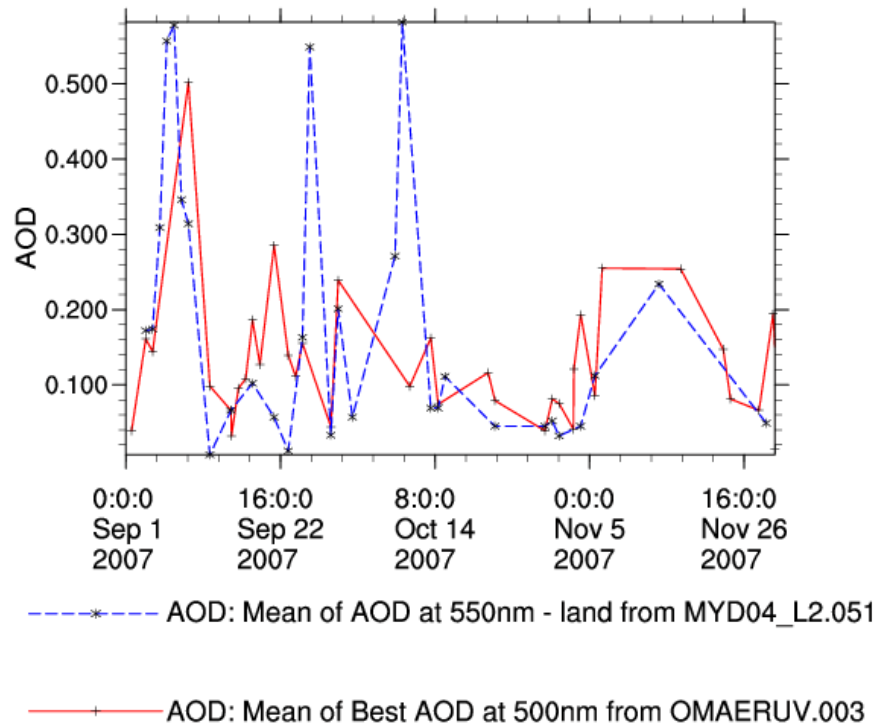
AOD Data quality information

Sensor	QA summary
AERONET	No QA flags, data at Level-2 is quality assured
MODIS	Integer flags, 0..3 (0=Bad, 3=Good)
MISR	Integer flag, 0..3 (0=Good, 3=Bad)
OMI	Integer flag, 0..7 (0=Good, 3..7=Bad)
POLDER	Combination of several real numbers, [0..1] [Bad .. Good]
CALIOP	Combination of several real numbers, [0..1] [Bad .. Good]
SeaWiFS	Integer flags, 0..3 (0=Bad, 3=Good)

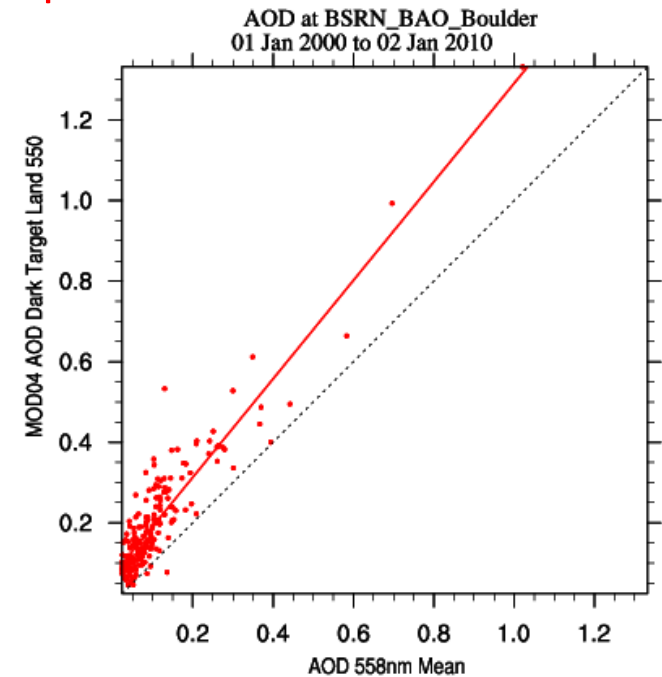
WEB MAPSS outputs

Time series

Time Series



Scatter plot*



• MOD04 AOD Dark Target Land 550 Mean (nval >= 5, QAavg-1 = 3, None)

— $y = 1.223x + 0.068$, $RMS = 0.059$, $R^2 = 0.846$, $N = 194$

-- 1:1

Comma-separated (CSV) data file

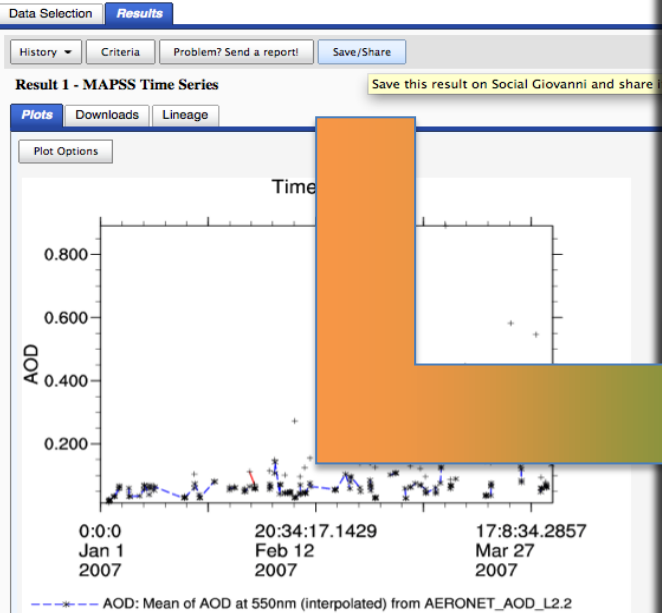
Title: MAPSS MAPSS Time Series				
Start date: 2006-01-01				
End date: 2007-12-31				
Station(s):				
datetime	mean_AERONET_AOD_L2_2_AOD0670_Dakar	mean_MOD04_L2_051_AOD0660corr_1_Dakar	mean_MYD04_L2_051_AOD0660corr_1_Dakar	mean_MIL2ASAE_0022_AOD0672b_Dakar
1/1/06 12:20	0.38	0.19		
1/4/06 14:15			0.49	
1/5/06 11:55		0.11		
1/9/06 11:30	0.22	-0.04		
1/9/06 14:33			-0.01	
1/12/06 12:00		0.14		
1/13/06 14:09	0.23		0.1	
1/13/06 14:24	0.23			
1/14/06 11:45	0.3	0.18		
1/14/06 11:49				

GSocial

FaceBook-like social networking system for sharing and discussing results of aerosol analysis in Giovanni

MAPSS: Multi-sensor Aerosol Products Sampling System

This user interface is used to obtain selected parameter statistics from the [MAPSS](#) database for a chosen location and time period. Time Series service. Plot output is rendered as a graph and is also available in ASCII format.



Social Giovanni

Home > Groups > GSocial testbed

mpetrenk

- Public Newsfeed
- My Newsfeed
- My Research Notebook
- My account
- Tags
- All Groups
- Help
- Log out

My groups

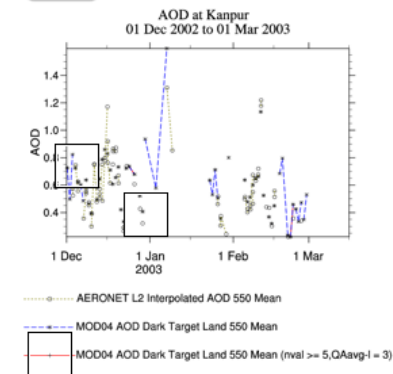
Not a member of any groups.

same MOD04_L2.051but with different filtering options 2002-12-01 to 2003-03-01T23:59:59Z)

Tue, 11/15/2011 - 20:26 - jpetrouh

Add Annotation

Tags: Kanpur same variable different options



Load this Result and Modify Criteria
Show/Hide criteria

Add new comment Share this

Tue, 11/15/2011 - 21:31 - jpetrouh

The problem is NCL, as I said in the email. NCL can not connect the line if they are "fillvalue". Now the question is whether this fillvalue is in the time or in the AOD itself.

reply

Post new Comment

Body:

AeroStat

- System for statistical analysis and correction of the systematic biases that might exist in aerosol measurements
 - Neural network algorithm uses MAPSS co-located data to “**learn**” about possible biases in the measurements, in relation to the corresponding measurement conditions
 - E.g., AOD can be overestimated if cloud fraction is high
 - The learned properties of the data can be used to **correct** the biases in the original Level-2 data
 - E.g., reduce retrieved AOD for pixels with high cloud fraction

AeroStat in Giovanni

- Simplified interface
- Provided data
 - MAPSS data
 - Level 2 data
 - Subsetted “on the fly”
- Bias adjustment
- Plotting
 - Time series
 - Scatter plot
 - Lat/Lon map
- Annual repeating month date range

AeroStat Online Platform for Statistical Inter-comparison of Aerosols
Version 1.0 [Release Notes](#) [Browser Compatibility](#) [HELP](#)

AeroStat Giovanni allows online analysis of aerosol collocated with Aeronet stations. This user interface is used to obtain statistics of selected parameters. The description of generating statistics is at [AeroStat](#). Scatter Plot, Time Series, and Lat-Lon Map are the available services. Plot output is rendered as a graph and is also available in ASCII format.

Data Selection | **Results**

To create a plot, choose from the criteria below and click **Get Plot(s)**

Select Service

Satellite Collocated with AERONET

☐ Time Series - Multiple Y-variables vs Time [Details](#)

☒ Scatter Plot - Multiple Y-variables vs the same X-variable [Details](#)

Satellite Only

☐ Lat-Lon Map - Map of daily data [Details](#)

Select Station

Click "Browse" button or type in name of stations

Select Measurements

Click each list below (beginning with the left-most list) to show the set of fully qualified measurements. Select a measurement and then click "Add". Repeat for additional measurements.

Product	Parameter	Layer	Measurement
AERONET L2 AOD, ver. 2	AOD Dark Target Land	470nm	mean
MISR L2 AOD, ver. 0022	AOD Dark Target Ocean	550nm	median
MODIS Aqua L2 AOD, ver. 051	AOD Deep Blue at 550nm	660nm	
MODIS Terra L2 AOD, ver. 051	AOD Deep Blue		

[More about MODIS Aqua L2 AOD, ver. 051 ...](#) [More about AOD Dark Target Land ...](#) [More about 550nm ...](#) [More about mean ...](#)

Selected Measurements

X-Axis AERONET L2 AOD, ver. 2 : Interpolated AOD : 550nm : mean

No. of Pixels: ☐ Not Filtered ☒ ≥ 2

Y-Axis MODIS Aqua L2 AOD, ver. 051 : AOD Dark Target Land : 550nm : mean

No. of Pixels: ☐ Not Filtered ☒ ≥ 5

QA: ☐ Not Filtered ☐ ≥ 1 (Marginal or Better) ☐ ≥ 2 (Good or Better) ☒ ≥ 3 (Very good)

Bias Adjustment: ☒ None ☐ Neural Network

Select Date Range

☐ Date Picker ☒ Annual Repeating Months

Select months to repeat then select the repeat period.

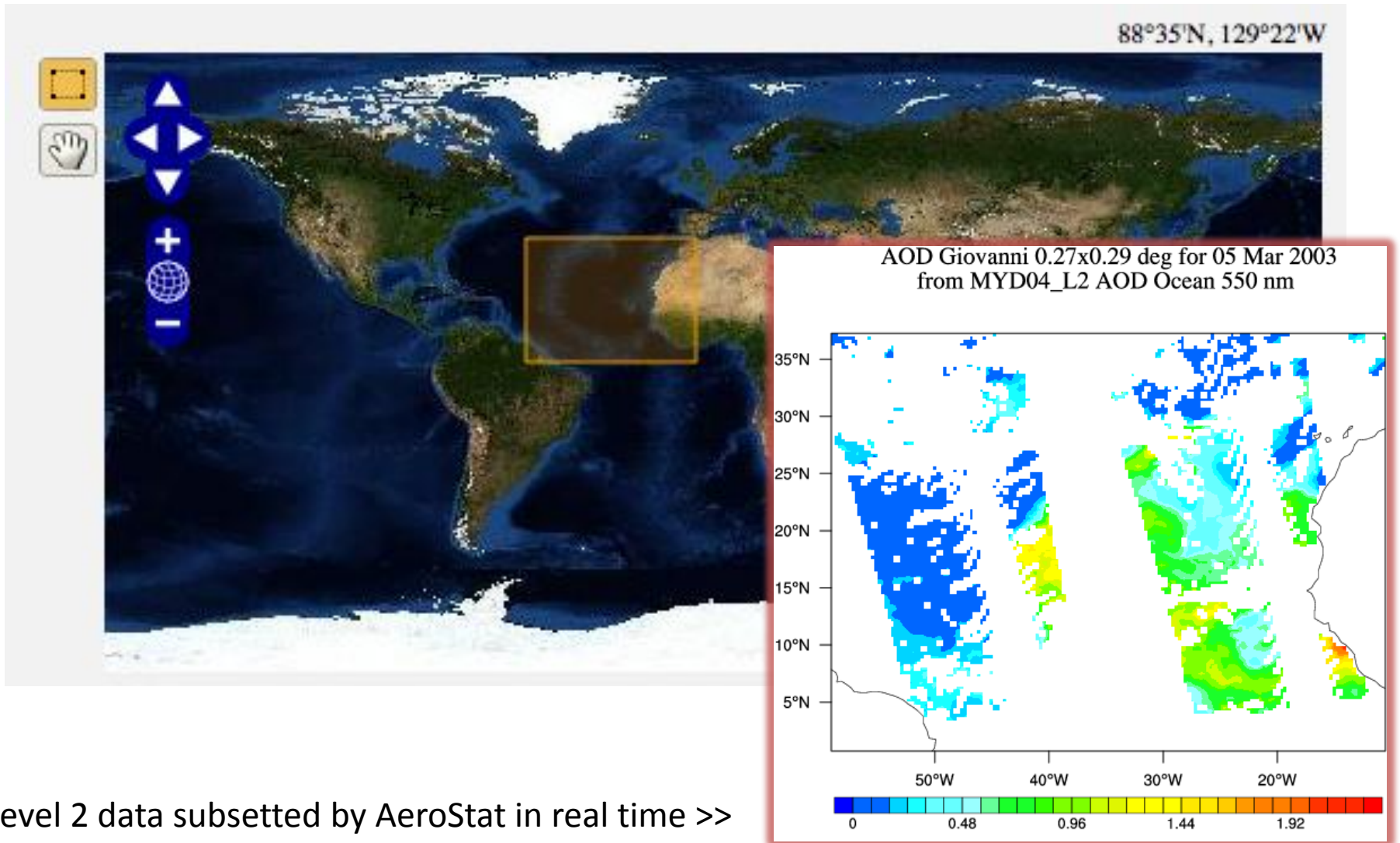
Months to Repeat: June through August

Repeat From: 1996 to 2011

To create a plot, choose from the criteria above and click **Get Plot(s)**

Support for the development of this online platform for the statistical intercomparison of aerosols has been provided by NASA HQ (PM: Stephen Berrick) through the [ROSES 2009 ACCESS Program](#) (PI: Gregory Leptoukh). The [AERONET](#) data are contributed by the International AERONET Federation (PI: Brent Holben).

AeroStat: Lat/Lon map



Level 2 data subsetting by AeroStat in real time >>

Summary

- MAPSS provides the consistent and convenient framework for integrated analysis and validation of aerosol products from multiple sensors
- Aerosol products are sampled by the MAPSS system on a daily basis and served through the FTP archive of CSV files, and also through the interactive **MAPSS** and **AeroStat Giovanni** interfaces
- The unified format and structure of the sampled data sets facilitates automated analysis of the uncertainties in aerosol retrievals

Future

- Aerosol uncertainty analysis and exploration tool (interactive scatter plot, map, etc)
- Extended support for Level-2 data plotting and analysis
- User-configurable Level-2 data merging, accounting for uncertainties
- Multi-faceted search and GUI redesign (also, update data access!)
- Improved collaborative capabilities

Acknowledgement

- NASA HQ Program Managers:
 - Hal Maring.
 - Martha Maiden.
 - Steve Berrick.For tag-team Funding support of this series of projects.
- Aerosol Products Teams
 - AERONET: Brent Holben, David Giles, Ilya Slutsker
 - MODIS: Lorraine Remer, Rob Levy
 - MISR: Ralph Kahn
 - OMI: Omar Torres
 - POLDER: Didier Tanre, Fabrice Ducos, Jacques Descloitres
 - CALIOP: Dave Winker, Ali Omar
 - SeaWiFS: Christina Hsu
- Giovanni Team